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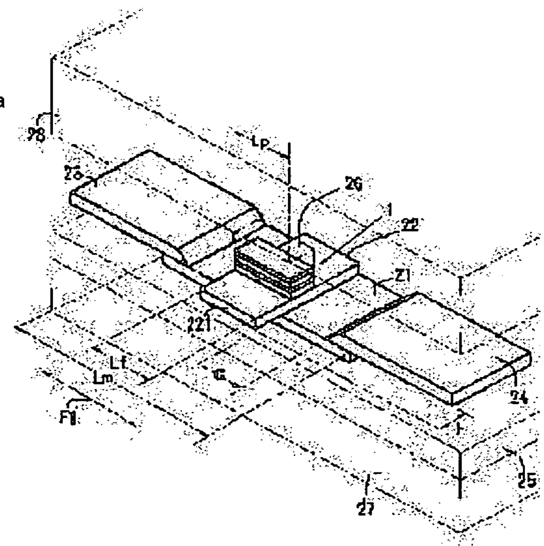
(54) TUNNEL MAGNETO-RESISTANCE EFFECT ELEMENT, THIN FILM MAGNETIC HEAD, MAGNETIC HEAD DEVICE AND MAGNETIC DISK DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a TMR element having a highly precise reading track width and applicable to high density recording.
SOLUTION: A ferromagnetic tunnel effect film 1 has a structure where a tunnel barrier layer 11 is held between a free layer 12 and a pinned layer 13. A bias magnetic field inductive layer 21 applies a bias magnetic field to the free layer 12, and has a width seen in the direction F1 of the bias magnetic field larger than that of the ferromagnetic tunnel effect film 1. A flux guide layer 22 is laminated on the bias magnetic field inductive layer 21, and magnetically couple to the free layer 12, one end thereof constituting a flux probing part 221. The flux probing part 221 has a width narrower than that of the bias magnetic field inductive layer 21, and is protruded from the bias magnetic field inductive layer 21.



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CLAIMS

[Claim(s)]
[Claim 1] It is a tunnel magneto-resistive effect component containing ferromagnetic tunnel effect film, a bias field induction layer, and a flux guide layer. Said ferromagnetic tunnel effect film Said tunnel barrier layer of said pinned layer [free layer and said pinned layer] is pinched including a tunnel barrier layer, a free layer, and a pinned layer. Said bias field induction layer A bias field is impressed to said free layer, and width of face seen in the direction of a bias field is larger than width of face of said ferromagnetic tunnel effect film. Said flux guide layer As the direction of a bias field of said bias field induction layer is intersected, while a laminating is carried out to said bias field induction layer It is the tunnel magneto-resistive effect component which it was magnetically combined with said free layer, and an end constituted the flux probe section, and the width of face of said flux probe section is narrower than width of face of said bias field induction layer, and has been projected from said bias field induction layer.
[Claim 2] It is the tunnel magneto-resistive effect component with which it is the tunnel magneto-resistive effect component indicated by claim 1, the laminating of said ferromagnetic tunnel effect film is carried out to order of said free layer, said tunnel barrier layer, and said pinned layer, the laminating of said flux guide layer is carried out on said bias field induction layer, and said free layer of said ferromagnetic tunnel effect film adjoins a flux guide layer.
[Claim 3] It is the tunnel magneto-resistive effect component said whose flux guide layer it is the tunnel magneto-resistive effect component indicated by claim 2, and is said free layer and this body.
[Claim 4] It is the tunnel magneto-resistive effect component by which it is the tunnel magneto-resistive effect component indicated by claim 1, the laminating of said ferromagnetic tunnel effect film is carried out to order of said pinned layer, said tunnel barrier layer, and said free layer, said bias field induction layer adjoins said free layer, and the laminating of said flux guide layer is carried out on said bias field induction layer.
[Claim 5] It is the tunnel magneto-resistive effect component which it is the tunnel magneto-resistive effect component indicated by any [claim 1 thru/or] of 4 they are, said bias field induction layer has a bias grant means, and said bias grant means contacts crosswise both ends of said bias field induction layer, and has spacing G between crosswise edges of said pinned layer.
[Claim 6] It is the tunnel magneto-resistive effect component which is a tunnel magneto-resistive effect component indicated by claim 5 and by which said bias means is constituted from a layered product of a high coercive force ingredient, an antiferromagnetism ingredient or an antiferromagnetism layer, and ferromagnetic layer much more at least.
[Claim 7] It is the tunnel magneto-resistive effect component to which it is the tunnel magneto-resistive effect component indicated by any [claim 1 thru/or] of 6 they are, and said pinning layer carries out pinning of the magnetization of said pinned layer further including a pinning layer.
[Claim 8] It is the tunnel magneto-resistive effect component which it has an electrode of a pair further, is a tunnel magneto-resistive effect component indicated by any [claim 1 thru/or] of 7 they are, opposite arrangement of the electrode of said pair is carried out so that said ferromagnetic tunnel effect film may be inserted in the direction of a laminating, and is electrically joined to said ferromagnetic tunnel effect film.
[Claim 9] It is the tunnel magnetic resistance element by which opposite arrangement is carried out so that it may be the tunnel magneto-resistive effect component indicated by claim 8 and shielding film of said pair may sandwich an electrode of said pair further including shielding film of a pair.
[Claim 10] It is the thin film magnetic head which it is the thin film magnetic head containing at least one read-out component, and said read-out component becomes with a tunnel magneto-resistive effect component indicated by any of claim 1 **** they are.
[Claim 11] The thin film magnetic head which is the thin film magnetic head indicated by claim 10, and contains at least one write-in component further.
[Claim 12] the thin film magnetic head indicated by claim 11 — it is — said write-in component — an induction type — electromagnetism — a sensing element — it is — said induction type — electromagnetism — the thin film magnetic head from which a sensing element contains the 1st magnetic film, 2nd magnetic film, and gap film, each end is separated with said gap film, and said the 1st magnetic film and said 2nd magnetic film constitute the write-in pole section.
[Claim 13] the thin film magnetic head indicated by claim 11 — it is — said write-in component — an induction type — electromagnetism — a sensing element — it is — said induction type — electromagnetism — the thin film magnetic head with which said 1st magnetic film contains the main pole and an auxiliary magnetic pole including the 1st magnetic film and the 2nd magnetic film in a sensing element, said main pole constitutes the perpendicular

write-in pole section, and said auxiliary magnetic pole has combined magnetically said main pole and said 1st magnetic film.
[Claim 14] It is magnetic-head equipment with which are magnetic-head equipment containing the thin film magnetic head and head means for supporting, and said thin film magnetic head was indicated by any [claim 10 thru/or] of 13 they are, and said head means for supporting come to support said thin film magnetic head.
[Claim 15] It is the magnetic disk drive with which are a magnetic disk drive containing magnetic-head equipment and a magnetic disk, and said magnetic-head equipment was indicated by claim 14, and said magnetic disk comes to carry out magnetic recording and playback between said magnetic-head equipment.
[Claim 16] It is the manufacture approach of ferromagnetic tunnel effect film including a process which is the manufacture approach of ferromagnetic tunnel effect film, and cleans a front face which said tunnel barrier layer of said pinned layer [free layer and said pinned layer] is pinched including a tunnel barrier layer, a free layer, and a pinned layer, and said ferromagnetic tunnel effect film forms before membrane formation of said each class by ion etching.
[Claim 17] It is the manufacture approach of a tunnel magneto-resistive effect component including a process which is the manufacture approach of a tunnel magneto-resistive effect component containing ferromagnetic tunnel effect film, and cleans a front face which said tunnel barrier layer of said pinned layer [free layer and said pinned layer] is pinched including a tunnel barrier layer, a free layer, and a pinned layer, and said ferromagnetic tunnel effect film forms before membrane formation of said each class by ion etching.
[Claim 18] It is the approach of manufacturing the thin film magnetic head containing at least one read-out component. Said read-out component Ferromagnetic tunnel effect film is included. Said ferromagnetic tunnel effect film A manufacture approach of the thin film magnetic head including a process which cleans a front face which said tunnel barrier layer of said pinned layer [free layer and said pinned layer] is pinched, and forms membranes before membrane formation of said each class including a tunnel barrier layer, a free layer, and a pinned layer by ion etching.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a tunnel magneto-resistive effect component (a TMR component is called below), the thin film magnetic head, magnetic-head equipment, and a magnetic disk drive.
[0002]
[Description of the Prior Art] The head of high sensitivity and high power is demanded in connection with the densification of a hard disk (HDD). The TMR component attracts attention as what meets this demand. The TMR component uses the ferromagnetic tunnel effect film which consists of multilayer structure of a ferromagnetic layer / tunnel barrier layer / ferromagnetic layer. The ferromagnetic tunnel effect means the phenomenon in which the tunnel current which flows a tunnel barrier layer changes depending on whenever [angular relation / of magnetization of both ferromagnetic layers], when passing a current between the ferromagnetic layers of the pair whose tunnel barrier layer is pinched. The tunnel barrier layer in this case is a thin insulator layer, and it can pass an electron, saving spin according to the tunnel effect.
[0003] In the TMR component, it is reported that 12% or more of resistance rate-of-change **R/R is shown. about [from which application of magnetic HEDDOHE still began although such a TMR component was expected as a next-generation sensor which replaces the sensor which used the spin bulb film (the Spin Valve film and the following SV film are called)] — it is — as one of the present technical problems — a TMR property — the maximum student or **** — development of new head structure is mentioned. That is, in order for the ferromagnetic tunnel effect film itself to take the geometric structure of passing a current in the thickness direction of a cascade screen, the design of new head structure by which the conventional proposal is not made is required.
[0004] The conventional example which applied the TMR component to magnetic-head structure is indicated by U.S.P.5,729,410, U.S.P.5,898,547, U.S.P.5,898,548, U.S.P.5,901,018, etc. In these official reports, the technical improvement is proposed that it can respond mainly to super-high density record. However, the development demand of the TMR magnetic head to super-high density record will become more advanced, and it waits eagerly for the proposal of the highly efficient TMR magnetic head also compared with the former.
[0005] For example, when using a TMR component as a reading component of the thin film magnetic head, electric short-circuit may occur after the time of polish processing, or polish processing, and the structure of exposing the tunnel barrier layer which consists of a thin insulating layer to a polishing side is not desirable. As a means to avoid such a problem, this invention persons proposed flux probe section type TMR structure previously (Japanese Patent Application No. No. 188472 [11 to]). In this advanced technology, the point of the soft magnetism layer both directly contacted on the ferromagnetic tunnel effect film which arranges the ferromagnetic tunnel effect film in the location into which it withdrew from the polishing side is drawn to the polishing side as the flux probe section. The flux probe section is formed by using a part of free layer of the ferromagnetic tunnel effect film, or newly adding the soft magnetism layer in which size differs from the ferromagnetic tunnel effect film.
[0006] There is another important role in the soft magnetism layer given in order to form the flux probe section. It is a role of a bias field flare part which gives the longitudinal bias field from a hard magnet or the antiferromagnetic substance to the free layer of the ferromagnetic tunnel effect film.
[0007] However, the short-circuit between ferromagnetics will occur on account of the geometric structure which said previously that a hard magnet etc. is contacted to the edge of the ferromagnetic tunnel effect film, and TMR rate of change will be lost by it.
[0008] Moreover, although the short-circuit between ferromagnetics is not generated when a hard magnet etc. is directly contacted for any of the up ferromagnetic of the ferromagnetic tunnel effect film, or a lower ferromagnetic being, a current flows through a hard magnet etc. and TMR rate of change deteriorates.
[0009] As a means to avoid such a problem, this invention persons made T-like configuration the soft magnetism film which constitute the flux probe section, and extended the base of the flux probe section crosswise [truck], it considered as the configuration where width of face be wider than the ferromagnetic tunnel effect film, and the structure which form a hard magnet or an antiferromagnetism layer in a part for the both ends be proposed (Japanese Patent Application No. No. 171869 [11 to]).
[0010] By the way, in connection with the densification of record, it must reduce and the magnetic record pattern recorded on media must also reduce the area of the TMR component carried in the reproducing head in connection with it. For example, in order to make it adapted for the recording density of 40Gbspi, a TMR component must be reduced even to the size of 0.4x0.4 (micrometer2) extent. A detailed mask is formed in formation of such a detailed

pattern with a photolithography technique, and the technique of carrying out pattern NINGU of the metal membrane by ion milling is taken.
[0011] However, with a current photolithography technique, as proposed previously, when the flux probe section and a bias field flare part are constituted from one soft magnetism film, the part of the angle of the flux probe section will be round as a pattern is made detailed. since the regenerative-track width of face of a head is determined by the width of face of the flux probe section when a TMR component is used as a reading component of the thin film magnetic head -- such an angle -- being round -- it becomes the cause of the variation in the width of recording track and is not desirable.
[0012] Although it is necessary to introduce EB exposure technique etc. in order to avoid such a problem, the lateness of a throughput is a problem and equipment itself is a large sum.
[0013] Moreover, when a soft magnetism layer is made into the bigger rectangle than a TMR component instead of the shape of T, it becomes impossible to make the width of recording track smaller than a TMR component, and is not desirable.
[0014]
[Problem(s) to be Solved by the Invention] The technical problem of this invention is to offer a TMR component applicable to super-high density record, the thin film magnetic head, magnetic-head equipment, and a magnetic disk drive.
[0015] Another technical problem of this invention is offering the TMR component which has the highly precise reading width of recording track, the thin film magnetic head, magnetic-head equipment, and a magnetic disk drive.
[0016]
[Means for Solving the Problem] In order to solve such a technical problem, the TMR component concerning this invention contains the ferromagnetic tunnel effect film, a bias field induction layer, and a flux guide layer.
[0017] As for said ferromagnetic tunnel effect film, said tunnel barrier layer of said pinned layer [free layer and said pinned layer] is pinched including the tunnel barrier layer, the free layer, and the pinned layer.
[0018] Said bias field induction layer impresses a bias field to said free layer, and the width of face seen in the direction of a bias field is larger than the width of face of said ferromagnetic tunnel effect film.
[0019] As said flux guide layer intersects the direction of the bias field of said bias field induction layer, while a laminating is carried out to said bias field induction layer, it was magnetically combined with said free layer, and the end constituted the flux probe section, the width of face of said flux probe section is narrower than the width of face seen in the direction of the bias field of said bias field induction layer, and it is projected from said bias field induction layer.
[0020] The TMR component concerning this invention has the ferromagnetic tunnel effect film which consists of multilayer structure of a free layer / tunnel barrier layer / pinned layer, and when a current is passed between the free layers and pinned layers whose tunnel barrier layer is pinched, the tunnel current which flows a tunnel barrier layer changes depending on whenever [angular relation / of the magnetization between a free layer and a pinned layer] (the TMR effectiveness). Although the direction of magnetization of a pinned layer is immobilization, the direction of magnetization of a free layer changes according to an external magnetic field. Therefore, an external magnetic field is detectable by detecting the current which flows for a TMR component, or its rate of change.
[0021] The TMR component concerning this invention contains a bias field induction layer. A bias field induction layer impresses a bias field to said free layer. Thereby, the Barkhausen noise in a free layer can be removed and the detecting signal of high quality can be obtained. As for the bias field induction layer, the width of face seen by the longitudinal direction has become larger than the width of face of said ferromagnetic tunnel effect film. Therefore, spacing can be separated from the ferromagnetic tunnel effect film to a part for the both ends of the cross direction of a bias field induction layer, and a bias grant means can be formed in it. For this reason, the short-circuit between ferromagnetics by the bias grant means etc. is avoidable.
[0022] Furthermore, the TMR component concerning this invention contains a flux guide layer. A flux guide layer is magnetically combined with a free layer, and an end constitutes the flux probe section. This flux probe section is projected from the bias field induction layer. An external magnetic field is introduced from the flux probe section, passes along a flux guide layer, and is impressed to a free layer. Therefore, in application to the thin film magnetic head etc., the flux probe section is located in a polishing side, and the ferromagnetic tunnel effect film can be arranged in the location into which it withdrew from the polishing side. For this reason, it is avoidable that electric short-circuit occurs in a tunnel barrier layer after the time of polish processing or polish processing.
[0023] The width of face of the flux probe section is narrower than the width of face seen in the direction of the bias field of a bias field induction layer, and since it has projected from the bias field induction layer, when it uses as a reading component of the thin film magnetic head, the regenerative-track width of face of a head can be set as the minute value determined by the width of face of the flux probe section.
[0024] And since the laminating of the flux guide layer is carried out to the bias field induction layer and it is layer with an another bias field induction layer, it can be formed according to membrane formation process that a bias field induction layer is another.
[0025] The flux guide layer intersects the direction of the bias field of a bias field induction layer, and the end constitutes the flux probe section. Therefore, also when a flux guide layer produces a radius of circle in an edge, the radius-of-circle part can be removed and the part by which the width-of-face dimension was stabilized can be used as the flux probe section. For this reason, the TMR component which has the highly precise reading width of recording track can be obtained.

[0026] In a concrete mode, the laminating of the ferromagnetic tunnel effect film is carried out to the order of a free layer and tunnel barrier layer and a pinned layer, or a laminating is carried out to the order of a pinned layer, a tunnel barrier layer, and a free layer.
[0027] When the ferromagnetic tunnel effect film has the structure which carried out the laminating to the order of a free layer and tunnel barrier layer and a pinned layer, the laminating of the flux guide layer can be carried out on a bias field induction layer, and the structure of making the free layer of the TMR film adjoining a flux guide layer can be adopted. In this case, a flux guide layer can be formed in a free layer and this body.
[0028] When the ferromagnetic tunnel effect film has the structure which carried out the laminating to the order of a pinned layer, a tunnel barrier layer, and a free layer, a bias field induction layer can be made to be able to adjoin a free layer, and the structure which carries out the laminating of the flux guide layer on a bias field induction layer can be adopted.
[0029] The bias field induction layer has the bias grant means, and a bias grant means contacts the both ends of the cross direction of a bias field induction layer, and it has a tooth space between the crosswise edges of a pinned layer. According to this structure, the short-circuit between ferromagnetics and the circumference lump of a current are avoidable. A bias means may consist of layered products of a high coercive force ingredient, an antiferromagnetism ingredient or an antiferromagnetism layer, and ferromagnetic layer much more at least. Moreover, the ferromagnetic tunnel effect film contains a pinning layer. This pinning layer carries out pinning of the magnetization of a pinned layer.
[0030] This invention is indicated again also about the electrode structure, the shielding structure over the ferromagnetic tunnel effect film, the thin film magnetic head that read the TMR component and was further used as a component, the magnetic-head equipment using this thin film magnetic head, and the magnetic disk drive for passing a current on the ferromagnetic tunnel effect film. This invention is further indicated also about the manufacture approach of the ferromagnetic tunnel effect film.
[0031]
[Embodiment of the Invention] The perspective view showing one example of the TMR component which drawing 1 requires for this invention, the expanded sectional view of the TMR component which showed drawing 2 to drawing 1 , and drawing 3 are the sectional views which met three to 3 line of drawing 2 . These drawings are exaggeratingly illustrated so that he can understand the description part of this invention easily. The perimeter of the part shown by hatching is covered with the nonmagnetic insulating layer which becomes with the ceramics etc.
[0032] The illustrated TMR component contains the ferromagnetic tunnel effect film 1, the bias field induction layer 21, and the flux guide layer 22. The ferromagnetic tunnel effect film 1 includes the tunnel barrier layer 11, the free layer 12, and a pinned layer 13. The tunnel barrier layer 11 of a pinned layer [the free layer 12 and] 13 is pinched.
[0033] The free layer 12 acts so that the external magnetic field which is magnetic information fundamentally may be answered and the sense of magnetization may be changed freely. Moreover, pinning of the pinned layer 13 is carried out so that the whole of the magnetization direction may turn to the fixed direction. Therefore, the laminating of the pinning layer 14 for carrying out pinning of the magnetization of a pinned layer 13 is usually carried out to a field opposite to the side which touches the tunnel barrier layer 11 of a pinned layer 13.
[0034] The bias field induction layer 21 impresses a bias field to the free layer 12, and the width of face seen in the direction of the bias field F1 is larger than the width of face of the ferromagnetic tunnel effect film 1. The bias field induction layer 21 has the bias means 23 and 24. The bias field of the free layer 12 is impressed through the bias field induction layer 21 by the bias grant means 23 and 24. The bias means 23 and 24 may consist of layered products of a high coercive force ingredient, an antiferromagnetism ingredient or an antiferromagnetism layer, and ferromagnetic layer much more at least.
[0035] As the direction F1 of the bias field of the bias field induction layer 21 and the flux guide layer 22 cross at right angles mostly, the laminating is carried out to the bias field induction layer 21. It was further combined with the free layer 12 magnetically, and the end constituted the flux probe section 221, the width of face of the flux guide layer 22 is narrower than the width of face of the bias field induction layer 21, and it has projected the flux probe section 221 from the bias field induction layer 21.
[0036] In the illustration example, the laminating of the ferromagnetic tunnel effect film 1 is carried out to the order of the free layer 12, the tunnel barrier layer 11, and a pinned layer 13. The laminating of the flux guide layer 22 is directly carried out on the bias field induction layer 21. The free layer 12 of the ferromagnetic tunnel effect film 1 is contacted and formed on the whole surface of the flux guide layer 22.
[0037] The TMR component concerning this invention has the ferromagnetic tunnel effect film 1 which consists of multilayer structure of the 11/pinned layer 13 of 12/tunnel barrier layers of free layers, and when a current is passed between the free layers 12 and pinned layers 13 whose tunnel barrier layer 11 is pinched, the tunnel current which flows the tunnel barrier layer 11 changes depending on whenever [angular relation / of the magnetization between the free layer 12 and a pinned layer 13]. Although the direction of magnetization of a pinned layer 13 is immobilization, the direction of magnetization of the free layer 12 changes according to an external magnetic field. Therefore, an external magnetic field is detectable by detecting the current which flows for a TMR component, or its rate of change.
[0038] Since a TMR component impresses a bias field to the free layer 12 by the bias field induction layer 21 including the bias field induction layer 21, it can remove the Barkhausen noise in the free layer 12, and can obtain the detecting signal of high quality. Since the width of face seen in the direction F1 of a bias field is larger than the width of face of the ferromagnetic tunnel effect film 1, the bias field induction layer 21 can separate spacing G from

the ferromagnetic tunnel effect film 1 to a part for the both ends of the cross direction of the bias field induction layer 21, and can form the bias grant means 23 and 24 in it. For this reason, the electric short-circuit between the free layer 12-pinned layers 13 by the bias grant means 23 and 24 etc. is avoidable.
[0039] Furthermore, the TMR component concerning this invention contains the flux guide layer 22. The flux guide layer 22 is magnetically combined with the free layer 12, and the end constitutes the flux probe section 221. This flux probe section 221 is projected from the bias field induction layer 21. An external magnetic field is introduced from the flux probe section 221, passes along the flux guide layer 22, and is impressed to the free layer 12. Therefore, in application to the thin film magnetic head etc., the flux probe section 221 is located in the polishing side PS 1 (refer to drawing 3), and the ferromagnetic tunnel effect film 1 can be arranged in the location into which it withdrew from the polishing side PS 1. For this reason, it is avoidable that electric short-circuit occurs in the tunnel barrier layer 11 after the time of polish processing or polish processing.
[0040] The width of face Lf of the flux probe section 221 is narrower than the width of face Lm of the bias field induction layer 21, and since it is projected from the bias field induction layer 21, when the TMR component concerned is used as a reading component of the thin film magnetic head, it can set the regenerative-track width of face of a head as the minute value determined by the width of face Lf of the flux probe section 221.
[0041] And since the flux guide layer 22 is layer with the another bias field induction layer 21, it can form the flux guide layer 22 according to membrane formation process that the bias field induction layer 21 is another. The flux guide layer 22 intersects the direction F1 of the bias field of the bias field induction layer 21, and the end constitutes the flux probe section 221. Therefore, also when the flux guide layer 22 produces a radius of circle in the edge, the radius-of-circle part can be removed and the interstitial segment by which the width-of-face dimension was stabilized can be used as the flux probe section 221. For this reason, the TMR component which has the highly precise reading width of recording track can be obtained.
[0042] The width of face Lp of the ferromagnetic tunnel effect film 1 is equal to the width of face Lf of the flux probe section 221, or is set up greatly smaller than the width of face Lm of the bias field induction layer 21. Width of face Lf of about 0.5-4 micrometers and the flux probe section 221 is set to about 0.1-2 micrometers for the width of face Lm of the bias field induction layer 21.
[0043] Furthermore, 0.01-0.3 micrometers depth H [0.01-0.2 micrometers] of the flux guide layer 22 is preferably set as 0.01-0.1 micrometers still more preferably. Although the more infinite one near 0 of this H value is good, the danger of an electrostatic discharge arises or the electric short danger of the free layer 12 and pinned layer 13 in a polish process arises as it becomes small. Therefore, a lower limit is good to be referred to as about 0.01 micrometers. On the other hand, if this H value exceeds 0.3 micrometers, an output will decline, or a crosswise bias field will become inadequate and a Barkhausen noise will arise.
[0044] Opposite arrangement of the electrodes 25 and 26 of a pair is carried out at the upper and lower sides of the direction of a laminating of the ferromagnetic tunnel effect film 1. A sense current is supplied to the ferromagnetic tunnel effect film 1 with the electrodes 25 and 26 of this pair. Opposite arrangement of the magnetic-shielding layers 27 and 28 of a pair is carried out so that these may furthermore be covered, respectively.
[0045] As for the bias field induction layer 21, a bias field is impressed crosswise by the bias grant means 23 and 24. The width of face Lm of the bias field induction layer 21 is set up more greatly than the width of face Lp of a pinned layer 13, and the bias field induction layer 21 serves as a gestalt to which only the part with the width of face Lm longer than the die length Lp of a pinned layer 13 equipped the both ends at least with the extension, respectively.
[0046] In order to make it not reduce TMR rate of change substantially, as for spacing G, setting to the predetermined range is desirable. If the numeric value experimentally found out as a desirable mode is mentioned, as for especially the spacing G, it will be desirable to consider as the range 0.02 micrometers or more of 0.3 micrometers or less, and the 0.02 more micrometer or more range of less than 0.15 micrometers 0.02 micrometers or more.
[0047] When the value of spacing G is set to less than 0.02 micrometers, it is in the inclination for TMR rate of change to fall. If this G value becomes large too much and exceeds 0.3 micrometers on the other hand, the inclination which the effective width of recording track spreads and stops agreeing in the future demand to a raise in recording density will arise.
[0048] Moreover, although especially the thickness of the free layer 12 in this invention is not limited, it is good preferably to set [2-5nm / 4-3nm] it as the range of 6-2nm more preferably. If this thickness is set to less than 2nm, it will become difficult on a membrane formation technique to make width of face Lm of the cross direction of the bias field induction layer 21 into sufficient magnitude. Moreover, if this thickness exceeds 50nm, by dispersion in the property of the free layer 12 interior, distribution of electron spin polarizability will arise and un-arranging [that TMR rate of change will decrease as a result] will arise.
[0049] The quality of the material which constitutes the free layer 12 and a pinned layer 13 has a desirable high spin polarization ingredient so that high TMR rate of change may be obtained, for example, Fe, Co, nickel, FeCo, NiFe, CoZrNb, FeCoNi, etc. are used. These may be the layered products more than two-layer. As mentioned above, 2-5nm of thickness of the free layer 12 is preferably set to 6-2nm. If there is an inclination for an output to decline if thickness becomes thick too much and thickness becomes thin too much, magnetic properties will become unstable and un-arranging [that the noise at the time of head actuation increases] will arise. 1-10nm of thickness of a pinned layer 13 is preferably set to 2-5nm. If pinning of the magnetization by the pinning layer 14 will become weaker if thickness becomes thick too much, and thickness becomes thin too much, the inclination for TMR rate of change to decrease will arise.

[0050] Although the pinning layer 14 which carries out pinning of the magnetization of a pinned layer 13 will not be especially limited if the pinning function is achieved, an antiferromagnetism ingredient is usually used. Thickness is usually set to about 60-5nm.
[0051] The tunnel barrier layer 11 consists of A1203, NiO, GdO, MgO, Ta 2O5, MoO2 and TiO2, and WO2 grade. Although it is desirable that it is thin as much as possible for the reduction in resistance of a component, it is too thin not much, and leakage current will drop off and the thickness of the tunnel barrier layer 11 is not desirable, if a pinhole is generated. Generally, it may be about 0.5-2nm.
[0052] voice also with desirable also using the free layer 12 as the synthetic ferry magnet (synthetic ferrimagnet) illustrated by the three-layer layered product of for example, a NiFe layer (2nm in thickness) / Ru layer (0.7nm in thickness) / NiFe layer (2.5nm in thickness) in this invention -- it is one [like]. In this case, the magnetization direction of an up-and-down NiFe layer and a NiFe layer is hard flow mutually, respectively. Since the thickness of the effectual free layer 12 can be thinly set up when a synthetic ferry magnet is used, magnetic field sensibility improves and there is a merit that an output becomes large. Moreover, such a synthetic ferry magnet is applicable also to a pinned layer 13.
[0053] Moreover, in the gestalt of the above-mentioned operation, although the bias grant means 23 and 24 are arranged at the both-ends bottom of the free layer 12, they may be arranged to the down side, without being limited to this.
[0054] The perspective view showing another example of the TMR component which drawing 4 requires for this invention, the expanded sectional view of the TMR component which showed drawing 5 to drawing 4 , and drawing 6 are the sectional views which met six to 6 line of drawing 5 . In drawing, the same reference mark is attached about the same component as the component which appeared in drawing 1 -3. In this example, the laminating of the ferromagnetic tunnel effect film 1 is carried out to the order of the free layer 12, the tunnel barrier layer 11, and a pinned layer 13. The flux guide layer 22 is formed in the free layer 12 and this body. Although the flux guide layers 22 are the free layer 12 and this body, the bias field induction layer 21 is another layer, and the laminating of them is carried out on the bias field induction layer 21.
[0055] The perspective view showing another example of the TMR component which drawing 7 requires for this invention, and drawing 8 are the sectional views which met eight to 8 line of drawing 7 . In drawing, the same reference mark is attached about the same component as the component which appeared in drawing 1 -3. In this example, the ferromagnetic tunnel effect film 1 has the structure which carried out the laminating to the order of a pinned layer 13, the tunnel barrier layer 11, and the free layer 12. The bias field induction layer 21 adjoins the free layer 12, and the laminating of the flux guide layer 22 is carried out on the bias field induction layer 21. The flux guide layer 22 is another layer in the bias field induction layer 21.
[0056] The perspective view showing another example of the TMR component which drawing 9 requires for this invention, and drawing 10 are the sectional views which met ten to 10 line of drawing 9 . In drawing, the same reference mark is attached about the same component as the component which appeared in drawing 1 -3. In this example, the ferromagnetic tunnel effect film 1 has the structure which carried out the laminating to the order of a pinned layer 13, the tunnel barrier layer 11, and the free layer 12. The bias field induction layer 21 is formed in the free layer 12 and this body. The flux guide layer 22 is another layer in the bias field induction layer 21, and the laminating is carried out on the bias field induction layer 21.
[0057] Next, with reference to drawing 11 -23, the production process of the bias field induction layer 21 and the FURRAKUSU guide layer 22 is especially explained about the manufacture approach of the TMR component illustrated to drawing 1 -3. Although the various thin film pattern formation techniques in which the photoresist method, ion milling, lift off, the spatter forming-membranes method, etc. are well-known are used on the occasion of manufacture, explanation of the individual detail technique is omitted here.
[0058] First, the bias field induction layer 21 is formed on the electrode layer 25 which carried out the laminating on the shielding layer 27 so that it may illustrate to drawing 11 and 12. The shielding layer 27 and the electrode layer 25 are covered with nonmagnetic insulating layers, such as ceramics.
[0059] The flux guide layer 22 is formed on the bias field induction layer 21 so that it may illustrate to degree drawing 13 and 14. In order to make it adapted for the recording density of 40Gbspi as mentioned above, the ferromagnetic tunnel effect film must be reduced even to the size of 0.4x0.4 (micrometer2) extent. The flux guide layer 22 also becomes a detailed pattern corresponding to the size mentioned above. If such a detailed pattern is formed with a photolithography technique, a radius of circle will be produced in the corner of the flux guide layer 22 so that it may illustrate to drawing 13 .
[0060] Next, as shown in drawing 15 , the ferromagnetic layer 13 used as the ferromagnetic layer 12 used as a free layer, the insulating layer 11 used as a tunnel barrier layer, and a pinned layer is formed on the bias field induction layer 21 and the flux guide layer 22. It is desirable to clean the front face which forms membranes before membrane formation of each class 11-14 by ion etching in membrane formation of these each class 11-14. According to such cleaning, it can avoid that a resist residual contamination layer or an oxidizing zone is formed in the interface of each class, and resistance increase of the ferromagnetic tunnel effect film finally obtained can be prevented.
[0061] Next, as shown in drawing 16 , the resist film 100 is formed in the front face of the ferromagnetic layer 13 by the predetermined pattern. The resist film 100 has the pattern extended to the proximal region of the flux guide layer 22 from the field with which the bias field induction layer 21 and the flux guide layer 22 lap.
[0062] And as shown in drawing 17 , ion milling etc. removes the part which is not covered with the resist film 100. Drawing 18 and 19 show the pattern after removal. As shown in drawing 18 and 19, the cascade screen of the

ferromagnetic layer 12, an insulating layer 11, and the ferromagnetic layer 13 is formed on the flux guide layer 22. The pattern of this cascade screen turns into the almost same pattern as the resist film 100.
[0063] Next, after exfoliating according to the means of common knowledge of the resist film 100, as shown in drawing 20 , another resist film 110 is formed by the predetermined pattern. The resist film 110 is formed so that it may become the pattern which the point which wore the radius of circle of the both ends of the bias field induction layer 21, and the point which wore the radius of circle of the flux probe film 22 expose. And as shown in drawing 21 , the point which wore the radius of circle of the both ends of the bias field induction layer 21 which is not covered with the resist film 110 with means, such as ion milling, and the point which wore the radius of circle of the flux probe film 22 are removed.
[0064] Drawing 22 and 23 show the condition after removing the resist film 110 after the milling mentioned above. The point which wore the radius of circle of both ends is removed, and patterning of the bias field induction layer 21 is carried out so that it may have die length predetermined by the stable width of face, so that it may illustrate. Moreover, the both ends which wore the radius of circle of the flux guide layer 22 are also removed, and it becomes the dimension stabilized by the width of face of the flux guide layer 22 and the ferromagnetic tunnel effect film on it.

[0065] Next, as shown in drawing 24 , as a part of front face of the ferromagnetic tunnel effect film 1 is exposed, it forms the resist film 120, and ion milling is performed as shown in drawing 25 . In this ion milling, milling of the ferromagnetic layer 13, the tunnel barrier layer 11, and the ferromagnetic layer 12 which constitute the ferromagnetic tunnel effect film 1 is carried out. Thereby, as shown in drawing 26 and 27, the flux guide layer 22 which has the flux probe edge 221 which projects with a predetermined dimension is obtained. The TMR component illustrated to drawing 4 -6 can also be manufactured according to the same process.
[0066] Next, with reference to drawing 28 -35, the manufacture approach of drawing 7 and the TMR component illustrated to 8 is explained. First, after forming the ferromagnetic layer 13 used as the ferromagnetic layer 12 used as a free layer, the insulating layer 11 used as a tunnel barrier layer, and a pinned layer on the electrode layer 25 which carried out the laminating on the shielding layer 27 so that it may illustrate to drawing 28 and 29, the bias field induction layer 21 is formed. The perimeter of the shielding layer 27, the electrode layer 25, the ferromagnetic layer 12, an insulating layer 11, and the ferromagnetic layer 13 is covered with nonmagnetic insulating layers, such as ceramics. As stated above, it is desirable to clean the front face which forms membranes before membrane formation of each class 11-14 by ion etching in membrane formation of each class 11-14 which constitutes the ferromagnetic tunnel effect film 1. According to such cleaning, it can avoid that a resist residual contamination layer or an oxidizing zone is formed in the interface of each class, and resistance increase of the ferromagnetic tunnel effect film finally obtained can be prevented.
[0067] The flux guide layer 22 is formed on the bias field induction layer 21 so that it may illustrate to degree drawing 30 and 31. In order to make it adapted for the recording density of 40Gbspi as mentioned above, the ferromagnetic tunnel effect film must be reduced even to the size of 0.4x0.4 (micrometer2) extent. The flux guide layer 22 also becomes a detailed pattern corresponding to the size mentioned above. If such a detailed pattern is formed with a photolithography technique, a radius of circle will be produced in the corner of the flux guide layer 22 so that it may illustrate to drawing 30 .
[0068] Next, as shown in drawing 32 , the resist film 130 is formed by the predetermined pattern. The resist film 130 is formed so that it may become the pattern which the point which wore the radius of circle of the both ends of the bias field induction layer 21, and the point which wore the radius of circle of the flux probe film 22 expose. And as shown in drawing 33 , means, such as ion milling, remove the both ends of the bias field induction layer 21 which is not covered with the resist film 130, and the point which wore the radius of circle of the flux probe film 22. Thereby, the bias field induction layer 21 by which width of face was stabilized, and the flux guide layer 22 are obtained.
[0069] Drawing 34 -36 show the configuration which removed the resist film 130 and was acquired after the milling mentioned above. The point which wore the radius of circle of both ends is removed, and patterning of the bias field induction layer 21 is carried out so that it may have die length predetermined by the stable width of face, so that it may illustrate. Moreover, the both ends which wore the radius of circle of the flux guide layer 22 are also removed, and it becomes the dimension stabilized by the width of face of the flux guide layer 22 and the ferromagnetic tunnel effect film on it. The flux guide layer 22 which has by this the flux probe edge 221 which projects with a predetermined dimension is obtained. Drawing 9 and the TMR component illustrated to 10 can also be manufactured according to the same process.
[0070] the TMR component which drawing 37 mentioned above — reading — as a component — using — an induction type — electromagnetism — the perspective view of the thin film magnetic head for the record within a field which wrote in the sensing element and was used as a component, and drawing 38 show the expanded sectional view of the thin film magnetic head shown in drawing 37 . The thin film magnetic head of illustration has the write-in component 5 which consisted of TMR components which start this invention on a slider 4 and which reads and becomes by the component 6 and the induction type MAG sensing element. An arrow head A1 shows the medium transit direction. In drawing, the dimension is exaggerated partially and differs from a dressed size.
[0071] A slider 4 has rails 41 and 42 in a medium opposed face side, and the front face of a rail is used as ABS 43 and 44. Rails 41 and 42 are not restricted to two. It may become the flat surface which may have 1-3 rails and does not have a rail. Moreover, various geometry may be given to a medium opposed face for a surfacing property improvement etc. Even if it is the slider 4 of which type, application of this invention is possible. Moreover, since a slider 4 is equipped with protective coats, such as DLC which has about 8-10nm thickness, on the surface of a rail,

in such a case, the front face of a protective coat serves as ABS 43 and 44. A slider 4 is the ceramic structure which formed aluminum 2O3 and the inorganic insulator layer 420 of SiO2 grade in the front face of the base 410 which becomes by aluminum2O3-TiC etc.

[0072] Both one side [of rails 41 and 42] or trailing . edge TR side is equipped with the write-in component 5 and the reading component 6. a slider 4 is equipped with the write-in component 5 and the reading component 6 -- having -- electromagnetism -- the edge for conversion is located in ABS 43 and 44 and the location which approached. The ejection electrodes 47 and 48 which were connected to the write-in component 5 and which took out and were connected to electrodes 45 and 46 and the reading component 6 are formed in the slider side face in the trailing . edge TR side, respectively.

[0073] The write-in component 5 has the gap film 54, an insulator layer 55, a protective coat 56, etc. which become with the 1st magnetic film 51 which serves as the 2nd [to the reading component 6] shielding film, the 2nd magnetic film 52, the coil film 53, an alumina, etc. Independently of the 1st magnetic film 51, you may have the 2nd shielding film.

[0074] The end sections (point) 510 and 520 of the 1st magnetic film 51 and the 2nd magnetic film 52 are the pole section which separates the gap film 54 of minute thickness and counters, and write in in the pole section. The 1st and 2nd magnetic films 51 and 52 may be monolayers, and may be double layer membrane structures. Double layer membrane-ization of the 1st and 2nd magnetic films 51 and 52 may be performed for the purpose of for example, a property improvement. Various amelioration and a proposal are made also about the structure of the pole section from viewpoints, such as improvement in narrow-izing of the width of recording track, and record capacity. In this invention, any pole structure proposed until now is employable. The gap film 54 is constituted by inorganic insulator layers, such as non-magnetic metal film or an alumina.

[0075] The 2nd magnetic film 52 inclines and starts to a pole section side at a certain include angle to a field parallel to the field of the gap film 54. Further, the 2nd magnetic film 52 maintains an inner gap between the 1st magnetic film 51, is prolonged behind ABS 43 and 44, and is combined with the 2nd magnetic film 52 in back. Thereby, the thin film magnetic circuit involving the 1st magnetic film 51, 2nd magnetic film 52, and gap film 54 is completed.

[0076] The coil film 53 is inserted between the 1st and 2nd magnetic films 51 and 52, and turns around the surroundings of a back bond part to a curled form. It has flowed through the both ends of the coil film 53 in the ejection electrodes 45 and 46 (refer to drawing 37). The number of turns and number of layers of the coil film 53 are arbitrary. The coil film 53 is laid under the interior of an insulator layer 55.

[0077] The interior of the inner gap between the 1st and 2nd magnetic films 51 and 52 is filled up with the insulator layer 55. The front face of an insulator layer 55 is equipped with the 2nd magnetic film 52. An insulator layer 55 consists of organic insulation resin film or ceramic film. The example of representation of the ceramic film is 2Oaluminum3 film or SiO2 film. If the ceramic film constitutes an insulator layer 55, since the thermal expansion of an insulator layer 55 will become small as compared with the case where an organic compound insulator is used, a result good for reducing the amount of the maximum protrusions is obtained.

[0078] In the protective coat 56, the protective coat 56 has covered the write-in whole component 5. By this, the write-in whole component 5 will be protected by the protective coat 56. The protective coat 56 consists of inorganic insulating materials of aluminum 2O3 or SiO2 grade.

[0079] The reading component 6 consists of TMR components concerning this invention. This reading component 6 is arranged inside the insulator layer 63 between the 1st shielding film 61 and the 2nd shielding film 63. The insulator layer 63 is constituted by the alumina etc. The reading component 6 is connected to the ejection electrodes 47 and 48 which flow on the 1st shielding film 61 and the 2nd shielding film 62 (refer to drawing 37).

[0080] Drawing 39 is the expanded sectional view of the thin film magnetic head for vertical recording. In the illustrated thin film magnetic head for vertical recording, the 2nd magnetic film 52 contains the main pole 525 and the auxiliary magnetic pole 526. The main pole 525 constitutes the perpendicular write-in pole section, and the auxiliary magnetic pole 526 combines magnetically the main pole 525 and the 1st magnetic film 51. The 1st magnetic film 51 constitutes the return magnetic path of the magnetic flux produced from the main pole 525. The coil film 53 is wound around the surroundings of the main pole 525 and the auxiliary magnetic pole 526. Since it is substantially the same, explanation is abbreviated to the thin film magnetic head for the record within a field which showed other structures to drawing 37 . Since the description of magnetic recording using the thin film magnetic head for vertical recording magnetizes the magnetic-recording film of a magnetic disk in the direction which becomes perpendicular to a film surface and performs magnetic recording, it is that very high recording density is realizable.

[0081] The front view showing some magnetic-head equipments which drawing 40 requires for this invention, and drawing 41 are the bottom views of the magnetic-head equipment shown in drawing 40 . Magnetic-head equipment contains the thin film magnetic head 8 and the head means for supporting 7. The thin film magnetic head 8 is the thin film magnetic head concerning this invention explained with reference to drawing 37 -39.

[0082] The head means for supporting 7 have structure which attached the flexible body 71 which similarly becomes with a metallic thin plate in the free end in the end of the longitudinal direction of the base material 73 which becomes with a metallic thin plate, and attached the thin film magnetic head 8 in the inferior surface of tongue of this flexible body 71.

[0083] A flexible body 71 has two outside frame parts 75 and 76 which carry out abbreviation parallel with the longitudinal direction axis of a base material 73, and are extended, the transversal frame 74 which connects the outside frame parts 75 and 76 in the edge distant from the base material 73, and the ligula 72 which has been prolonged so that abbreviation parallel may be carried out from the abbreviation center section of the transversal

frame 74 at the outside frame parts 75 and 76, and used the tip as the free end.
[0084] The projection 77 for loads of the shape of a semi-sphere of a ligula 72 which upheaved from the base material 73 in the center section mostly is formed. The load force is told from the free end of a base material 73 by this projection 77 for loads to a ligula 72.
[0085] The thin film magnetic head 8 is attached in the inferior surface of tongue of a ligula 72 with means, such as adhesion. The thin film magnetic head 8 is attached in the ligula 72 so that an airstream appearance side edge side may become in the direction of a transversal frame 74. The head means for supporting 7 applicable to this invention are not restricted to the above-mentioned example.
[0086] Drawing 42 is drawing showing typically the configuration of the magnetic disk drive concerning this invention. The illustrated magnetic disk drive contains magnetic-head equipment 9 and a magnetic disk 10. Magnetic-head equipment 9 is illustrated to drawing 40 and 41. The end of the head means for supporting 7 is supported by the pointing device 11, and magnetic-head equipment 9 is driven. The thin film magnetic head 8 of magnetic-head equipment is supported by the head means for supporting 7, and it is arranged so that it may counter with the magnetic-recording side of a magnetic disk 10.
[0087] If the rotation drive of the magnetic disk 10 is carried out in the direction of an arrow head A1 by the driving gear which is not illustrated, the thin film magnetic head 8 will surface from the field of a magnetic disk 10 by the minute flying height. By the positioning device 11 which carries out the rotation drive of the head means for supporting 7, the thin film magnetic head 8 which the magnetic disk drive illustrated by drawing 42 is a drive method called a rotary . actuator method, and was attached in the point of the head means for supporting 7 is driven in the directions b1 or b2 of a path of a magnetic disk 10, and is positioned in the predetermined truck location on a magnetic disk 10. And magnetic recording by the write-in component 5 and reading actuation by the reading component 6 which has a TMR component are performed on a predetermined truck.
[0088] As mentioned above, although the contents of this invention were concretely explained with reference to the desirable example, it is obvious that various deformation modes can be taken based on the fundamental technical thought of this invention and instruction if it is this contractor.
[0089]
[Effect of the Invention] According to this invention, the following effectiveness can be acquired as stated above.
(a) A TMR component applicable to super-high density record, the thin film magnetic head, magnetic-head equipment, and a magnetic disk drive can be offered.
(b) The TMR component which has the highly precise reading width of recording track, the thin film magnetic head, magnetic-head equipment, and a magnetic disk drive can be offered.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view showing one example of the TMR component concerning this invention.
[Drawing 2] It is the expanded sectional view of the TMR component shown in drawing 1 .
[Drawing 3] It is the sectional view which met three to 3 line of drawing 2 .
[Drawing 4] It is the perspective view showing another example of the TMR component concerning this invention.
[Drawing 5] It is the expanded sectional view of the TMR component shown in drawing 4 .
[Drawing 6] It is the sectional view which met six to 6 line of drawing 5 .
[Drawing 7] It is the perspective view showing another example of the TMR component concerning this invention.
[Drawing 8] It is the sectional view which met eight to 8 line of drawing 7 .
[Drawing 9] It is the perspective view showing another example of the TMR component concerning this invention.
[Drawing 10] It is the sectional view which met ten to 10 line of drawing 9 .
[Drawing 11] It is drawing showing the process included in the manufacture approach of the TMR component illustrated to drawing 1 -3.
[Drawing 12] It is the sectional view which met 12 to 12 line of drawing 11 .
[Drawing 13] They are drawing 11 and drawing showing the process after the process shown in 12.
[Drawing 14] It is the sectional view which met 14 to 14 line of drawing 13 .
[Drawing 15] They are drawing 13 and the sectional view showing the process after the process shown in 14.
[Drawing 16] It is drawing showing the process after the process shown in drawing 15 .
[Drawing 17] It is the sectional view which met 17 to 17 line of drawing 16 .
[Drawing 18] They are drawing 16 and drawing showing the process after the process shown in 17.
[Drawing 19] It is the sectional view which met 19 to 19 line of drawing 18 .
[Drawing 20] They are drawing 18 and drawing showing the process after the process shown in 19.
[Drawing 21] It is the sectional view which met 21 to 21 line of drawing 20 .
[Drawing 22] They are drawing 20 and drawing showing the process after the process shown in 21.
[Drawing 23] It is the sectional view which met 23 to 23 line of drawing 22 .
[Drawing 24] They are drawing 22 and drawing showing the process after the process shown in 23.
[Drawing 25] It is the sectional view which met 25 to 25 line of drawing 24 .
[Drawing 26] They are drawing 24 and drawing showing the process after the process shown in 25.
[Drawing 27] It is the sectional view which met 27 to 27 line of drawing 26 .
[Drawing 28] It is drawing showing the process included in the manufacture approach of drawing 7 and the TMR component illustrated to 8.
[Drawing 29] It is the sectional view which met 29 to 29 line of drawing 28 .
[Drawing 30] They are drawing 28 and drawing showing the process after the process of 29.
[Drawing 31] It is the sectional view which met 31 to 31 line of drawing 30 .
[Drawing 32] They are drawing 30 and drawing showing the process after the process shown in 31.
[Drawing 33] It is the sectional view which met 33 to 33 line of drawing 32 .
[Drawing 34] It is drawing showing drawing 32 and the pattern pass the process of 33.
[Drawing 35] It is the sectional view which met 35 to 35 line of drawing 34 .
[Drawing 36] It is the sectional view which met 36 to 36 line of drawing 34 .
[Drawing 37] the TMR component concerning this invention — reading — as a component — using — an induction type — electromagnetism — perspective view **** of the thin film magnetic head for the record within a field which wrote in the sensing element and was used as a component.
[Drawing 38] It is the expanded sectional view of the thin film magnetic head shown in drawing 37 .
[Drawing 39] It is the expanded sectional view of the thin film magnetic head for vertical recording which read the TMR component concerning this invention and was used as a component.
[Drawing 40] It is the front view showing some magnetic-head equipments concerning this invention.
[Drawing 41] It is the front view showing some magnetic-head equipments concerning this invention.
[Drawing 42] It is drawing showing typically the configuration of the magnetic disk drive concerning this invention.
[Description of Notations]
1 Ferromagnetic Tunnel Effect Film
11 Tunnel Barrier Layer
12 Free Layer

13 Pinned Layer
21 Bias Field Induction Layer
22 Flux Guide Layer
221 Flux Probe Section

[Translation done.]